

July 16, 2003

TO: Internal File

THRU: Daron Haddock, Permit Supervisor

FROM: Gregg Galecki, Hydrologist

RE: Summary of Pacificorp Report on Electric Lake June 25, 2003 – Investigation of Technical Issues Related to the Electric Lake and Huntington Creek Drainage Controversy

The following is a brief summary of my review of the Pacificorp report on Electric Lake. The pertinent portions of the report will be incorporated into the Upper Huntington - Mud Creek CHIA. The following will outline the information in the report followed by a quick summary of my analysis. The Pacificorp report contains the following supplemental information: 1) changes in Electric Lake levels over time and comparisons to two other reservoirs (including 14 graphs); 2) observations of selected Canyon Fuel monitoring wells; 3) a Water Balance Calculation explanation and graph; 4) two (2) geophysical studies (Resistivity/IP and Aquatrack); 5) a diving / lake bottom video investigation; 6) a Tracer dye study; and 7) selected Water Quality / age-dating analysis.

- 1) **Changes in Electric Lake water levels** – Prior to 2002 there were no inflows measured coming into the lake. Inflows were calculated using the storage/lake elevation minus the outflows. This calculation is fine as long as inflows are high enough to cover the ‘margin-of-error’ such as evaporation, evapotranspiration, outflow measuring accuracy, etc. The actual calculations and information used to determine these calculated inflows was not included in the report. Also, beginning in 2001, the Lake levels dropped to their lowest levels in history in the middle of an extended drought. The majority of the graphs used to demonstrate the changes in the performance of the lake are based on the elevation of the lake. It is important to note that lake elevation may or may not be directly related to volume. The lake may drawdown differently with the same outflow at different elevations based on the surface area of the lake at those elevations. To feel comfortable in drawing similar conclusions suggested in graphs 1-9 I need to get the data from which the graphs were created.

Figure 2 appears to indicate that the lake ‘recharges’ every year with the obvious peaks in the lake elevation. However, from 1975 – 1987 one (1) recharge is missing, and by 1997, a second ‘recharge’ was missing. This may indicate that the lake is running at a ‘deficit’ that hasn’t been identified in the past.

A comparison was made to Figures 3 and 7 and drawdown patterns. However, the portion of drought conditions exhibited in Fig. 3 (1986-1990) lake elevations were above 8550-ft, while drought conditions in Fig. 7 (1999 - present ) were below 8525-ft which may affect the curve of the chart. I would like to compare total outflow numbers for these two periods and actual changes in storage, not just changes in elevation. Also in Fig. 3, from 1986 – 1993 lake elevation slopes are consistent, but seem to react independent of discharge.

When comparing Fig.5 (PHDI) to Fig. 6 (E. Lake Inflows) in the periods of 1986-1990 and 1999- present, total inflows appear higher in the 1986-1990 time period with a similar drought. Once again, I would like to take a look at the data.

Ultimately, I am not completely convinced with the information the graphs are presenting. I would like to get some of the data and create a few more graphs dealing with water volume changes. Also, I would like the data and equation used to calculate inflows.

- 2) **Monitoring Well information** – Using selected Canyon Fuel monitoring wells the report illustrates that water levels in the wells have dropped in ranges from 0 to 300-feet, with many dropping in elevation by more than 100-feet. However, the report does not distinguish the different geology in the wells, and the majority of the wells with elevation drops greater than 100-ft are drawing water from the Starpoint Sandstone which is located below the mine, or is completed in the Blackhawk Formation but extends through the coal seam. This does not support the draining of the lake very well.
- 3) **Water Balance Calculations and graph** – Figure 23 is a graph illustrating the ‘missing water from Electric Lake, but no data is available and the graph is difficult to understand.
- 4) **Geophysical Studies** – Both the Resistivity/IP and Aquatrack surveys indicated that apparently water is present in the Connelville and Diagonal faults. Both surveys made statements indicating that there is direct communication between Electric Lake and the mine. The Pacificorp report states, “water saturated zones however appear to get progressively deeper on the northern lines...”. However, a close evaluation of the Geo-Western data (Res./IP) suggests the water at depth in the northern lines is saline (saline water > 10,000 mg/l TDS – has never been encountered in the mine). Also, the deepest penetration of the survey was 400-ft below the lake and 350-feet above the mine. Neither survey can validate that water is ‘flowing’ along these paths, only that it appears water is present. In addition, both surveys only investigated areas where Pacificorp suspected water. No survey was conducted in other areas to determine whether these were the only areas outside the perimeter of the lake that were saturated with water. An example of additional surveys would be the southern extension of the Connelville/Diagonal fault, the O’Conner fault and around the dam.

- 5) **Diving / Lake bottom investigation** –An articulating-legged vehicle mounted with a video camera was employed to investigate the bottom of the lake. The survey discovered multiple series of venturi-shaped holes in the bottom of the lake located along an apparent extension of the Diagonal fault, Connelville fault, and another unnamed fault intersecting the O’Conner fault. The survey discovered both venturi-shaped holes where water was apparently escaping from the lake and where methane gas was venting from the lake bottom. It appears that the survey locations were selected based on the location of the known faults and areas where ice did not cover the lake. The features were located everywhere the survey was conducted. It would have been interesting to see if the same features existed in areas where they didn’t expect them, such as along the O’Conner fault, east of the O’Conner fault, and along the dam. The holes noted in the video are relatively small (on the order of a one-inch diameter) but it is hard to determine scale. Also, the actual movement of water is hard to detect in the video. When the water is intentionally disturbed to suspend the fine-particles, a sucking of the fines into the holes is not observed.
- 6) **Tracer Dye Study** –Based on locations sited during the lake-bottom investigation, two (2) areas were selected for dye placement where water was apparently leaving the lake. Great care was taken to extract water from within 6-inches of the bottom of the lake, mix it with the dye and re-inject the water back into the bottom of the lake. After re-injecting the dye-laced water back into the lake (at depths of 14.5-ft and 19.5-ft), water samples were collected from nearby holes drilled into the ice; confirming the dyed water was effectively stratified on the bottom of the lake. The amount of dye injected into the lake ( 35-lbs fluorescein, 50-lbs eosine) was based on anticipated travel distance and travel time. The study assumes a flow connection would permit water to move from Electric Lake into the mine within a period of approximately four (4) months (by August 2003). A total of 13 long-term sample stations were chosen, however a map indicating their exact location was not provided. Descriptions of sites include upstream of the dam in the water near the bottom, middle, and top of the lake, Eccles Creek below the Mine, JC-1, two (2) sites on Clear Creek, South Fork Eccles Creek, Boulger Creek, JC-3 once operational, and five (5) sites on Huntington Creek.
- 7) **Water Quality, Age-dating Analysis** –Water analysis conducted by Dr. Kip Solomon in September 2002, indicated water collected in the 10-Left area and JC-1 had a modern component that was approximately 5-years-old (+/- 3-years) based on tritogenic tritium sampling. It is estimated that approximately 10 percent of the water is of modern origin and 90 percent of the water is of aged origin. Also, the residence time of the water in the Starpoint Sandstone was estimated to be 1,000 – 10,000 years old.

Analysis of the gas emanating from the bottom of the lake is “typical of natural gas”. “Its low CO<sub>2</sub> content suggests that it is not from a shallow, biogenic source in the lake sediments.” The report suggests, “Such high flow rates are not typical of biogenic production in the lake sediments and suggest the gas is coming from depth.” However, the following should be kept in mind: 1) this is based on only one (1) sample collected; 2) Skyline has never had a problem with methane; 3) the coal bed in the vicinity of the Skyline mine has never been saturated to trap the gas that is now apparently being liberated; and 4) it is assumed that the gas being released began in 2001, we don’t know how long this has been occurring.

The above-cited comments represent my initial analysis of the Pacificorp information. Pacificorp will be contacted in the near future for clarification of portions of the report and a request for supporting data. Once clarified and validated, the pertinent information will be incorporated into the Mud Creek – Upper Huntington Creek CHIA.

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